more careful scientific study of the question, especially in hospitals.

Laboratory methods to explain the inner processes in disease have been applied to hospital patients for twenty years or more in Germany but in the United States little has been done in this regard. If such investigations are in any way promoted by their discussion here, this writing will not have been in vain.

In the second edition the scope of the book has not been changed, but advances that have been made during the past three years are included.

W. D. Bigelow

REPORT ON NEW ZEALAND SAND DUNES

The New Zealand Department of Lands has recently published a paper, by Dr. L. Cockayne, entitled "Report on the Sand Dunes of New Zealand" which treats of the geology and botany of the sand dunes and their economic bearing.

The first part of the article deals, in a general way, with the damage done by dunes, the objects of dune culture or reclamation and the description and acreage of the principal dune areas.

The dune question is attacked geologically in the second part of the paper. Here are discussed the origin of dune material; dune building, and the effects of various factors on the processes of dune formation and movement; and the various land forms of the dune area.

In treating the botanical features of the New Zealand dunes, in the third part, Dr. Cockayne sets forth the ecological factors governing their flora, and describes the most characteristic plants of the region and their "adaptations." He divides the plant life of the dunes into three groups, namely, sand binders, sand collectors and wet-ground plants. The methods of spreading of dune plants are also discussed. The subject of dune-plant associations is confined to dunes of western Wellington, though the author states that these may be taken as typical of those of the central floristic province of New Zealand. It is shown that each stage in the evolution of the dune possesses its characteristic plant association and also that "the plant-covering is an exact index of the wind force."

Among the important conclusions drawn by the author, the following may be mentioned:

It is useless to attempt artificial planting on many wandering dunes without shelter of the proper kind.

The neglect of wounds in the turf of stable dunes is perhaps the greatest source of danger to the adjacent fertile lands.

Under certain conditions a dune exposed to wind-tearing action may be naturally covered with shrubs and rendered stable without any previous preparation, except such shelter as is afforded by sand grass (*Spinifex hirsutus*).

In selecting shelter-plants for dune-afforestation purposes, tolerance of drifting sand is a matter of prime importance, without which drought or salt-resisting power are as nothing.

The paper is admirably illustrated by thirty-five excellent photographs and concludes with the citation of one hundred and thirteen works consulted in its preparation.

Charles S. Ridgway
Alabama Polytechnic Institute

SPECIAL ARTICLES

ON THE CONSERVATION OF HAILSTONES AND THE INVESTIGATION OF THEIR MICROSTRUCTURE

The investigation of microstructure of hailstones being till now very difficult if not impossible in summer, I constructed an apparatus (Fig. 1) for their conservation till winter-time. It consists of three coaxial cylinders; the inner space is intended for hail, the middle space for a mixture of ice and cupric sulfate (approximatively in proportion corresponding to eutectics, $t = -1°.6$), the outer space for ice, which forms a sort of guard-mantle.

During the summers 1908 and 1909 I had only once the chance of meeting a hail-storm —the 2/15 August, 1909, when I was at sea near Helsingfors on my way from Aland to St. Petersburg. This hail lasted from three to four minutes, the hailstones were very small

(2–3 mm. diameter), but still I gathered 200–300 gr. of them and immersed them—in order to prevent the freezing together—in glass boxes with a mixture of nearly equal parts of benzol and toluol which I presumed to be of a density equal to the density of hailstones, but which proved to be lighter. These hailstones I brought later to Tomsk (Siberia) and in December sent them to the Twelfth Congress of Russian Naturalists and Physicians in session at Moscow. These facts demonstrate thoroughly the possibility of con-

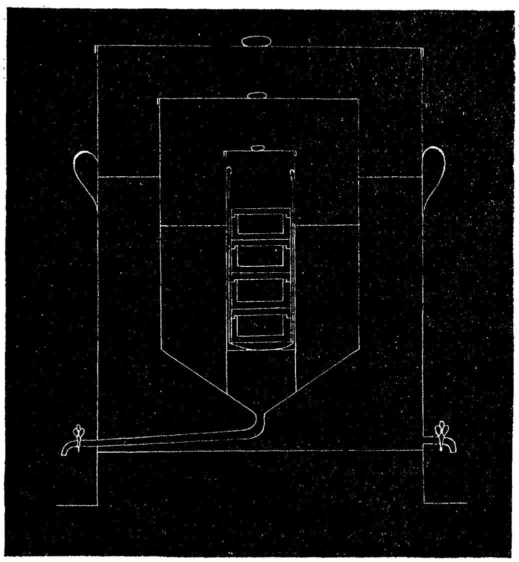

FIG. 1

servation of hailstones. My experiment has also shown that it would be preferable to conserve one or two hundred hailstones separate from each other, than a greater number of them, partly frozen together (especially in lower layers). That can be attained by inserting hailstones in some very viscous liquid (cylinder oil, vaseline, castor oil) of a density only nearly equal to that of hail.

For the investigation of the microstructure of a separate hailstone, Mr. W. Dudečki and I made a thin section of it by at first rubbing one side on emery-paper or by melting with the heat of a finger. This side was laid on an object-glass and frozen to it after touching during some time the other side of the glass with a finger; the other side of the hailstone was then polished in the same way as the first, till the requisite thickness was attained. These operations were so much easier, as the temperature of air was lower—below 0°. Still it was found possible to grind the hailstones in a room at the room-temperature, by means of cooling the object-glass, the emery-paper, etc., in double-walled vessels with mixture of ice and NaCl.

For the optical investigation of thin sections was used either a polarizing microscope

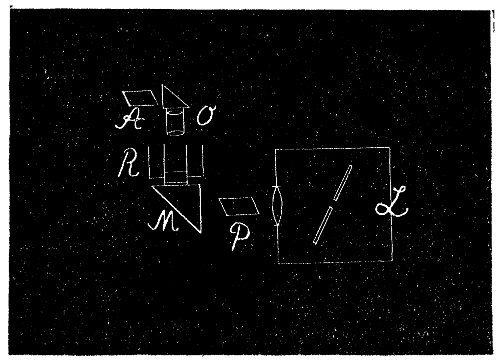

FIG. 2. *L*, projecting lantern; *P*, polarizator; *M*, mirror; *R*, refrigerating vessel; *O*, objective; *A*, analyzator.

or a projecting lantern *L* (Fig. 2). In this latter case the experiment was made in a lecture-room; the section was laid in a refrigerating vessel *R* with double walls and with double bottom (to prevent the condensation of the aqueous vapor from the surrounding air) of plane-parallel glass-plates; the space between the walls contained a mixture of ice and NaCl. The real image of section was projected on a screen or on a photographic ("autochrom") plate.

The major part of the hailstones were crystallic individuals, as also was the case with "artificial hailstones"—drops of water frozen in a mixture of cinnamon and linseed oil of suitable density. In those hailstones, which consisted of several crystallic individuals, there was no regularity in the boundaries between crystals in the angles between these bound-

aries, nor in the directions of the axes which lay indifferently to each other as well as to the milky nucleus which appeared in the section as a lot of air bubbles of different size.

I venture to hope that my attempt will call forth similar researches and would be glad if any other might have a chance to conserve or to study some bigger or more peculiar hailstones than I, and in this way improve our deficient notions about the origin of hail and the details of its formation.

Boris Weinberg

Physical Laboratory,
Technological Institute of Tomsk

A SPECULATION IN CRYSTALLOGRAPHY

The conception of six systems of crystallization, which has been prevalent for nearly a century, has doubtless impressed many students of the subject as somewhat arbitrary. Especially does it appear so when it assumes four axes for the hexagonal system and only three for each of the others. To be sure, these axes are simply lines of reference, and the systems are ingeniously formulated so as to include all possible forms, which can be produced by the regular arrangement of particles having uniform size and similar shape in each particular case. While the scheme of classification is comprehensive and practical, it has really no more foundation in nature than the Linnean orders and families of plants.

The real misuse of these systems, however, has been when the crystallographic axes have been assumed to correspond to molecular bonds, or to similarly related axes in each molecule of a given substance, so that the molecules of a crystal are conceived to be arranged in straight lines corresponding to these axes. While this idea, which is often used in text-books, may be helpful in the explanation of crystals and of crystalline forms, yet it can readily be shown to be arbitrary and unnatural and therefore liable to mislead.

The purpose of this paper is to outline a more rational explanation of crystal structure, constancy of angles, cleavage and other physical properties.

If we should use globules of uniform size to represent molecules, or ultimate particles of an isometric substance, and allow them to take their most compact form, as they would by their mutual attraction, or under the influence of uniform external pressure, they would not arrange themselves in lines corresponding to rectangular axes, as is so often indicated in crystallographic diagrams and models. Instead of each one touching its neighbor at *six* points, as it would in that case, it touches at *twelve* points. Nature often shows a similar fact in the globular cells of organic tissues. When such are crowded together until the intervening spaces are obliterated, each cell takes the form of a *rhombic dodecahedron.*

We, therefore, take this form as a promising suggestion and look at it more carefully. We see that if we draw lines through the centers of opposite planes, or, if with globules compactly arranged, we draw lines through the centers of each and through opposite points of contact, each will be traversed by six lines, and if space be filled with such dodecahedrons, or with equal-sized globules, such space will be traversed with straight lines running in six directions. Every such line, or axis, will form an angle of 60° with four of the others and 90° with the sixth.

If space permitted, we might show that by assuming such an arrangement of isometric molecules all the different planes of that system may be as logically derived as they can be from the commonly postulated arrangement parallel with rectangular axes. Starting with a single molecule, if we should add successive layers of similar molecules equally in all directions, the result would be a rhombic dodecahedron. If the obtuse interfacial angles, eight in number, were modified by one plane, because of some variation of molecular attraction, or because of different density of the generating solution, octohedral planes would appear. If, on the other hand, the acute angles, of which there are six, should be similarly modified, we should have cubic planes, and so on through all the forms of the isometric system.

But, as we should naturally expect from the